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Description

The invention relates to a turbocharger with a variable nozzle device for regulating the flow of exhaust gas driving a turbine.

In turbochargers comprising a turbine for driving a compressor impeller or the like, it is necessary to control the flow of the exhaust gas driving the turbine in order to achieve different operational conditions. Such a control is possible by arranging a plurality of vanes in a circular manner between a nozzle ring and the exhaust housing of the turbocharger. The vanes form a plurality of nozzle passages, wherein by arranging the vanes in a pivotable manner, it becomes possible to vary the throat area of the nozzle passages.

According to document WO 01/96713 A1, there is disclosed a turbocharger arrangement comprising a vane area formed between a nozzle ring and a ring member which is axially slidable with respect to the vanes.

It is the object of the invention to provide an improved turbocharger arrangement.

According to one aspect of the invention, the above object is achieved by a turbocharger defined in claim 1. Preferable embodiments of this turbocharger are set forth in the subclaims.

According to the technical solution defined in claim 1, the turbocharger comprises vanes interposed in a nozzle between a nozzle element and a floating insert supported axially slidably on the exhaust housing or turbine housing. By means of this arrangement, a gap between the turbine housing and the nozzle element can be kept closed at any operational condition in order to increase the overall turbine efficiency of the turbocharger and the regulation thereof, while at the same time, the risk of vane sticking is avoided.

In the turbocharger the floating insert can be urged against the vanes in said nozzle by a difference in the pressure in the exhaust gas inlet and the nozzle and/or by a biasing member supported on the exhaust housing. As biasing member a spring washer can be used which is placed preferably in a recess formed in the gas outlet or shroud portion of the turbine housing.

Alternatively, the biasing member can also be interposed in a recess formed in the floating insert. In this case, the floating insert is formed preferably of a sheet metal and has a C-shaped cross-section with the open portion facing the turbine housing.

In the turbocharger construction where the floating insert is arranged to be urged against the vanes in the nozzle by a difference in the pressures in the exhaust gas inlet and the nozzle, the space or recess formed between the insert and the turbine housing is communicated to the exhaust gas inlet of said exhaust housing preferably by cut-out portions in the insert.

For mounting the variable nozzle device, its nozzle element carrying a vane pivoting mechanism is preferably clamped between a step portion of an inner periphery of the turbine and a disc-shaped member supported on the center housing. According to an alternative construction of the turbocharger, the nozzle ring is abutted against the turbine housing by means of spacer elements passing through the floating insert and thus serving also as guiding means for guiding the movement of the floating insert.

For providing a pressure-free pivoting of the vanes at the initial stage of operation of the turbocharger, a spacer element is arranged on the nozzle ring for limiting the displacement of the insert towards the vanes. Furthermore, a piston ring can be provided between the floating insert and a gas outlet portion of the turbine housing.

In the following, further technical solutions of the object of the invention are described in detail with reference being made to the enclosed drawings.

In the drawings:

Fig. 1 is a cross-sectional view of a part of an exhaust gas turbocharger according to a first embodiment of the invention;

Fig. 2 is an enlarged cross-sectional view of the turbocharger shown in Fig. 1;

Fig. 3 is a cross-sectional view of a part of an exhaust gas turbocharger according to a second embodiment of the invention;

Fig. 4 is an enlarged cross-sectional view of the floating insert arrangement in the second embodiment shown in Fig. 3;

Fig. 5a and Fig. 5b are front and side views of the elastic spring washer used in each of the embodiments shown in Figs. 1 to 4;

Fig. 6 is a cross-sectional view of a part of an exhaust gas turbocharger according to a third embodiment of the invention;

Fig. 7a and Fig. 7b are front and cross-sectional views of a first embodiment of the floating insert used in the turbocharger according to the invention;

Fig. 8a and Fig. 8b are front and cross-sectional views of a second embodiment of the floating insert used in the turbocharger according to the invention;

Fig. 9a and Fig. 9b are front and cross-sectional views of a third embodiment of the floating insert used in the turbocharger according to the invention;

Fig. 10 is a cross-sectional view of a fourth embodiment of the turbocharger according to the invention;

Fig. 11a and Fig. 11b are front and cross-sectional views of the floating insert used in the fourth embodiment of the turbocharger shown in Fig. 10; and

Fig. 12 is a cross-sectional view of a fifth embodiment of the turbocharger according to the invention.

Fig. 1 shows a part of a turbocharger including a center housing 1 supporting a shaft 3 on which a turbine wheel 5 is mounted such that it extends within an exhaust or turbine housing 7 mounted on a flange member 9 of the center housing 1 by means of fastening bolts not particularly shown in Fig. 1.

As shown in Fig. 1, the exhaust housing 7 forms a generally scroll-shaped volute 11 receiving exhaust gas from an internal combustion engine. From the scroll-shaped volute 11 the exhaust gas is directed through an annular vane area forming a nozzle 13 into a turbine shroud 15 forming a portion of the turbine housing and encompassing the turbine wheel 5. The nozzle 13 is formed between a ring-shaped insert 17 supported on a first outlet portion 19 of the turbine housing and a nozzle ring 21. The nozzle ring 21 is fitted inside a second flange portion of the turbine housing by means of which the turbine housing is mounted to the center housing 1. The flange portion of the turbine housing has an inner stepped opening engaging with the nozzle ring 21 and urging the nozzle ring toward an elastic disc shroud 23 supported on the center housing 1 so that the nozzle ring becomes positioned in an axial direction of the turbocharger.

On the nozzle ring 21, a plurality of vanes particularly shown in Fig. 2 are mounted, said vanes extending within the nozzle 13

and forming a plurality of nozzle passages between themselves. The vanes 27 are associated with vane pins rotatably supported in the nozzle ring, wherein at the end of each vane pin facing the center housing 1, there is attached a vane arm 29 particularly shown in Fig. 3. The vane arm 29 is attached to the vane pin preferably by welding, so that the length of the vane pin which is axially slidable within the nozzle ring exceeds the thickness of the nozzle ring 21 thus enabling a slight axial movement of the vanes 27 forth and back in the nozzle. The ends of the vane arms 29 are received in slots of a unison ring 31 formed in its inner periphery. The unison ring 31 is supported by means of its inner periphery on at least three rollers 33 spaced from each other in a circumferential direction, said rollers being rotatably mounted on dowels 35 secured radially inwardly of the unison ring in respective holes of the nozzle ring 21. The rollers 33 include a peripheral groove for receiving the inner periphery of the unison ring 31.

In the embodiment shown in Fig. 1, the dowels 35 are secured at their two ends in holes of the flange member 9 and the nozzle ring 21 in order to prevent the nozzle ring from rotating. However, the prevention from rotation can be achieved also by separate means with all dowels being secured only in holes of the nozzle ring, or by only one dowel extending in both the flange member and the nozzle ring with the rest of the dowels extending only in holes of the nozzle ring. In all of these mounting modifications, the dowels serve as a radial support for the rollers which can rotate and slide axially on the dowels for following a rotation and/or axial distortion of the unison ring under minimum friction or resistance.

For actuating the unison ring an actuating system is used which is not particularly shown in the Figures. As such a system, e.g. a bell crank system described in the document US-A-4 804 316 can be used.

The ring-shaped insert 17 is provided at its outer peripheral portion with at least one dowel pin 37 slidingly accommodated in a corresponding hole of the exhaust housing 7. On the inner periphery of the ring-shaped insert 17, a circumferential recess is formed in order to accommodate a piston ring 39. Radially inwardly of the hole accommodating the dowel pin 37 there is provided a circumferential recess 41 in the exhaust housing, said recess accommodating an elastic spring washer 43 by means of which the ring-shaped insert 17 is urged against the side faces of the vanes 27 so that the vanes are sandwiched between the nozzle ring 21 and the ring-shaped insert with a well balanced pressure. Thus, the clearances of the contact portions between the vanes and the nozzle ring and the vanes and the ring-shaped insert can be reduced, and at the same time, the risk of vane sticking at these contact surfaces can be minimised due to the resilient contacting of these surfaces.

The thickness of the insert ring 17 can be dimensioned such that there remains a small clearance between the insert ring and the outlet portion 19 of the turbine housing for communicating the circumferential recess 41 with the volute 11. Due to this communication and preferably by using the piston ring 39 as a seal between the recess 41 and the nozzle 13, during operation of the turbocharger, the pressure within the circumferential recess 41 becomes higher than the dynamic flow pressure within the nozzle 13 so that the pressure difference creates an additional force urging the insert 17 toward the vanes forming the nozzle passages.

In the second embodiment of the turbocharger shown in Figs. 3 and 4, a spacer element 145 extending between a nozzle ring 121 and a first gas outlet portion 119 of the turbine housing 107 is arranged. The spacer element 145 serves as an axial support for the nozzle ring 121 which is urged against the first portion 119 of the turbine housing 107 by the elastic disk shroud 123.

A ring-shaped insert according to one of the embodiments shown in Figs. 7a to 9b can be used in the turbocharger of the second embodiment. In these embodiments, radially cut-out portions 149 by means of which the insert 117 is slidably engaged with the spacer elements 145 and prevented from rotating are provided in the periphery of the ring-shaped insert.

As shown in Figs. 8a and 8b, the ring-shaped insert 117, on its side facing the gas outlet portion 119 of the exhaust housing 7, is provided with axially cut-out portions 147 providing a communication of the circumferential recess 141 with the volute 111. Due to this communication, the pressure between the insert and the turbine housing becomes higher than the dynamic flow pressure within the nozzle 113 so that the pressure difference creates an additional force urging the insert 117 toward the vanes forming the nozzle passages.

In the second embodiment, the spacer elements 145 extend with their ends in both the turbine housing 107 and the nozzle ring 121 so that the provision of a locking element similar to the locking pin 26 used in the first embodiment shown in Fig. 2 is not necessary.

The third embodiment of the turbocharger according to the invention shown in Fig. 6 differs from the second embodiment shown in Fig. 3 mainly in that the former spacer element 145 is replaced by a sleeve spacer 245 penetrated by a bolt 251. The sleeve spacer 245 has an axial length longer than the sum of the axial thickness of the vanes 227 and the axial thickness of the ring-shaped insert 217, so that a very flat elastic spring washer (not shown in Fig. 6) can be placed in the space between the ring-shaped insert 217 and the gas outlet portion 219 of the exhaust housing 207.

In this embodiment, the same modifications of the ring-shaped insert shown in Figs. 7a to 9b can be used, as well.

The turbocharger according to the fourth embodiment shown in Fig. 10 is almost the same as the turbocharger shown in Fig. 6, with the exception that the ring-shaped insert 317 has an L-shaped cross-section which, in co-operation with the gas outlet portion 319 of the turbine housing, forms a circumferential space 341 containing an elastic spring washer 343. The piston ring 339 used in the fourth embodiment is accommodated within a recess formed in a portion of the turbine housing facing the inner periphery of the insert ring 317.

According to the above description, a substantial advantage of the invention is that the outer wall of the nozzle can be constituted by a relative small separate element which is not only exchangeable separately from the turbine housing, which as such integrally forms the volute and the outlet shroud encompassing the turbine, but is also flexibly adjustable towards the vanes, thus providing a limited clearance to the vanes and avoiding sticking hindering movement of the vanes.

The turbocharger according to a fifth embodiment is shown in Fig. 12. In this embodiment, the floating insert is designated with the reference sign 517. The floating insert 517 is in the form of a shroud having a flange 518. The flange 518 is interposed between the exhaust housing 507 and the center housing 51. At least one hole is formed in the flange 518 coinciding with a corresponding hole in the center housing 51. A locking pin 537 is passed through both holes so as to prevent the floating insert 517 from rotating relative to the center and exhaust housings 51, 507.

The flange 518 is fitted in an inner recess 541 formed in the exhaust housing 507. The axial width of the flange 518 is smaller than the axial width of the inner recess 541 such that also a spring member 543 can be accommodated within the recess

541. The spring member 543 axially urges the floating insert 517 towards the vanes 527.

The floating insert 517 is formed with a wall 516 which abuts against the vanes 527. Thereby, the vanes 527 are sandwiched between the floating insert 517 and the nozzle ring 521 by means of the spring member 543 in a floating manner in order to keep a constant nozzle width.

Such a construction provides a variable nozzle device which is not only arranged in a floating manner between the center housing 51 and the exhaust housing 507 but which also incorporates a nozzle ring 521 and the floating insert 517 being axially movable for floating with respect to each other, thus enabling a widening of the nozzle and therefore more efficiently avoiding sticking and binding of the vanes 527.

This embodiment advantageously facilitates the axial guiding of the floating insert 517 and reduces the component parts thereof.

The fifth embodiment may be modified as follows.

A modification of such a floating arrangement of the variable nozzle device can use the center housing design mentioned above, where the center housing is provided with an inner recess, with the floating insert 517 being accommodated in an axially movable manner within said recess.

The locking pin 537 may be attached to the exhaust housing.

Instead of the locking pin 537, another locking means may be provided. For instance, the inner recess in the exhaust housing may be provided with an irregular inner shape matching an outer shape of the floating insert so as to prevent the floating insert from rotating relative to the exhaust housing.

The spring member 543 may be omitted. In this case, an elastic disk shroud similar to the elastic disk shrouds 23, 123 of the preceding embodiments is used to urge the vanes 527 against the floating insert 517 via the nozzle ring 521.